

USING TECHNOLOGY WITH PRE-K AND
KINDERGARTEN
STUDENTS TO INCREASE EARLY NUMERACY
SKILLS

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2014

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
May, 2018

USING TECHNOLOGY WITH PRE-K AND KINDERGARTEN
STUDENTS TO INCREASE EARLY NUMERACY SKILLS

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Date of Degree: MAY, 2018

Title of Study: USING TECHNOLOGY WITH PRE-K AND KINDERGARTEN STUDENTS
TO INCREASE EARLY NUMERACY SKILLS

Major Field: EDUCATIONAL PSYCHOLOGY, OPTION IN SCHOOL PSYCHOLOGY

ABSTRACT: Building a strong foundation in the early numeracy gateway skills in pre-k and kindergarten has strong implications for future success in mathematics. Currently, very few research-based early numeracy interventions are available for students prior to first grade. Furthermore, the majority of current early numeracy interventions are administered individually. School psychologists are constantly striving to provide the most effective and efficient service delivery for all students with the universal goal to prevent and remedy skill deficits. With an increase of technology in schools, interventions utilizing basic technology would be time and cost effective. A multiple baseline design was used to validate a technology-based intervention across three early numeracy skills with a small group of pre-k and kindergarten students. The findings from this study provide empirical evidence that the NDM, a comprehensive, scripted intervention can be used in a small-group setting to increase early numeracy skills.

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CHAPTER I

INTRODUCTION

Competence in basic math facts and number sense is critical for early elementary students to achieve to succeed in more advanced mathematical procedures. A strong foundation in early numeracy skills fosters the development of quantitative awareness by providing foundational skills that are necessary for more complex skills. Specifically, when students are able to understand that numbers are representative of objects, relationships, and a variety of application concepts and are aware that numbers can be manipulated, compared, and used for communication, they are said to have adequate early numeracy and number sense skills (Markovits & Sowder, 1994).

Evidence is accumulating that the early elementary grades represent a pivotal time in which the investment of resources may maximize student outcomes in numeracy skills. Morgan, Farkas, and Wu (2009) found that students who were at or below the 10th percentile at the beginning of the year to the end of the year in kindergarten had a 70% chance that they would continue to be at the 10th percentile 5 years later. These results raise serious concerns and stresses the need for empirically-validated remediation tools that lead to improved student outcomes with early math skills. Early elementary school is a critical time and provides a window of opportunity for educators to implement high quality instruction to prevent and/or remedy basic math achievement deficits and provide students with a solid foundation upon which to build more complex mathematic skills.

Tier one instruction (i.e., the core curriculum) provided during whole group instruction is the foundation of academic success. However, not all students respond to the curriculum and make appropriate growth. It is important to identify these students early. Curriculum-based measurement (CBM) can be utilized to identify students at risk of academic failure and appropriately identify skills to target for intervention. Once a skill deficit is identified, interventions that target that skill can be implemented to remediate the issue. Early intervention is critical to prevent a student falling behind. To optimize academic learning and teacher's time, interventions can be administered in small groups.

The instructional structure and strategies used during intervention sessions can greatly impact student learning rates. Specifically, it is imperative that patterns in student responding on target skills are matched to the correct intervention procedures. A model that supports this practice is the Instructional Hierarchy (IH; Haring & Eaton, 1978). Specifically, the IH breaks down the learning process to defined stages (e.g., acquisition, fluency, generalization) and provides instructional components (e.g., demonstration, corrective feedback, drill) that should be used to remediate associated deficits. Another set of instructional procedures that have been supported in the literature is direct instruction. Direct instruction is an educational model that uses scaffolding, clear communication and presentation, and prompt feedback and support. Direct Instruction's use of explicit instruction and guided practice is an effective method of increasing accurate learning (Marchand-Martella, et al., 2004).

Although literature exists outlining general procedures that result in student learning very few scripted interventions exist that support the development of early numeracy skills. Although early numeracy skills such as number-identification, may predict later mathematics success (Fuchs et al., 2007), research on early prevention is scarce. There are limited studies that have examined effective interventions to remediate early numeracy skill deficits (Gersten, Jordan, & Flojo, 2005).

This paper will be reviewing research on increasing early numeracy skills during early childhood. The research explored will include the specific gateway skills of early numeracy, use of Curriculum Based Measurement, the Instructional Hierarchy, direct instruction, and current types of numeracy interventions. The reviewed literature will support the development and evaluation of three Early Numeracy Modules to increase skills related to number identification, object counting, and number writing. The study will attempt to empirically validate these NDMs with a small group of kindergarten students using automated PowerPoint slides.

CHAPTER II

REVIEW OF LITERATURE

Mathematics Deficits

A student's early success in mathematic can have long-term effects. In 2008, the National Mathematics Advisory Panel released a collection of research results, best practices, and general guidelines for promoting and improving math development for students in America. The results in the Trends in International Mathematics and Science Study (2007) ranked 4th grade students in America 11th out of 36 nations and 8th grade students 9th out of 48 countries in the study (Olson, Martin, & Mullis, 2008). Daughtery (2003) presented results from the National Longitudinal Survey of Youth which suggest that numeracy has a highly significant effect on earnings in adulthood. Daughtery attributed this effect of numeracy's influence on students being able to attend and graduate from college, which can lead to higher paying jobs. These findings suggest a need for early intervention and remediation in mathematics.

Response to Intervention and Prevention

Core mathematics instruction is essential to the development of students' early numeracy skills (Fuchs & Vaughn, 2012). Instruction provided during whole group instruction is the primary level of school failure prevention in a multitier model such as Response to Intervention (RTI). RTI is based on a three-tiered model. The first tier is comprised of universal academic and behavioral support systems to all students in general education classes. School personnel screen all students on academic skills at least three times a year (Gartland & Strosnider, 2005). Through

the screeners, students who are below standardized grade-level benchmarks are considered at-risk of falling behind and academic failure.

To appropriately serve these students, teachers and school staff provide additional supports and the student is placed in Tier 2. Within Tier 2, students receive targeted evidence-based interventions to proactively remediate their skill deficits. For a school to effectively support students in Tier 2, their Tier 1 must be effectively teaching approximately 80% of the student population. However, this is not always the case for schools. Sometimes the general education curriculum is not sufficient for the majority of students and supplements to the curriculum are required. These supplements can include extra whole group instruction, differentiated small group instruction, or class-wide interventions to fill in curricular gaps.

Curriculum Based Measurement

Curriculum Based Measurement (CBM) was developed by Deno & Mirkin (1977) and is an assessment that uses a standardized set of administration and scoring procedures with probes that comprise foundational grade-level skills for reading, math, and writing. CBM is a way for schools to identify students needing interventions to prevent academic failure. There are a variety of individuals and companies that provide CBM materials and related support (e.g., AIMSweb, DIBELS) across various academic skills. These different providers have assessments that produce data to address four primary purposes. The first is for screening. Data from CBM assessments can rank order students from lowest to highest and can be used to identify students in need of additional instruction to increase skills. CBM can be used to screen Tier 1 students at the elementary school level (Shinn, 1989). CBM is more helpful for direct measurement of a skill in the same setting in which students are taught a skill, in the classroom. The second is finding the student's current instructional level. The data collected through CBM can also be used to establish appropriate, and attainable goals. The third purpose is progress monitoring. When

intervening with a student it is imperative that teachers assess student progress to see how they are responding to the intervention. This is critically important because the educator does not want to be spending extra resources providing an intervention that is not benefiting the student. The fourth purpose is systemic problem solving. To do this, a multidisciplinary team (e.g., administrator, school psychologist, curriculum director) would compile and analyze the school's data and determine areas that need improvement or support. For all CBM, it is important that educators assessing students using CBM procedures strictly adhere to the administration guidelines, examples include reading the scripted directions verbatim, adhering to the strict time limits, and scoring procedures.

Mathematics-CBM (M-CBM) has been researched less often in the early elementary grades as compared to other CBM measures, such as reading. M-CBM has been researched for validity (Foegen, Jiban, & Deno, 2007), reliability (L. S. Fuchs, Fuchs, Hamlett, & Stecker, 1990), and results suggest that M-CBM is useful to monitor student progress over short time frames because of their sensitivity (L. S. Fuchs, Fuchs, Hamlett, & Stecker, 1991). These properties make M-CBM a uniquely favorable tool for assessing student progress in math. Included in M-CBM is early numeracy skills.

Early Numeracy-CBM (CBM-EN) consists of assessment resources of prerequisite skills needed to build a foundation for number sense and operations. Assessment should start with the most basic skill early numeracy skill, oral counting, and continue through the more complex grade level skills to find the student's instructional level. Once assessment data has been collected the appropriate target skill for intervention can be identified and it can be decided if the problem is class-wide or only a select number of students need Tier 2 services. Early numeracy skills typically include identifying numbers, orally counting, and number quantity discrimination.

Preliminary research suggests that Early Numeracy-CBM (CBM-EN) have adequate reliability, validity, and sensitivity for pre-school through first grade students (Clarke & Shinn, 2004). Clark & Shinn (2004) also found that Number Identification to be the most reliable measure amongst Missing Number, Quantity Discrimination and Object Counting. In addition, the results suggested that the floor effects for Missing Number and Quantity Discrimination were more significant in the beginning of kindergarten and the measures may be less useful than Number Identification and Object Counting (Clark & Shinn, 2004). Floor effects constrict the sensitivity of the measurement for lower functioning students.

In 2001, VanDerHeyden, Witt, Naquin, and Noell assessed the reliability and validity of CBM probes for kindergarten students. These probes were designed to be time-efficient, have multiple versions of the test, administered class-wide, directly linked to the grade-level curriculum, and inexpensive to use. For the math portion, VanDerHeyden et al., used the Circle Number Probe, Write Number Probe, and Draw Circles Probe (2001). The Circle Number Probe requires the student to count how many circles are shown and then circle the corresponding digit from a string of numbers to the right of the circles. The number of circles per question ranged from 1 to 10. On the Write Number Probe, the student counts the number of circles displayed on one side of the probe and then writes the correct numeral that represents the number of circles. The Write Number Probe task combines skills: ability to count objects and recall the identification of the number of objects, and fluency of number writing. The Draw Circles Probes is the reverse of Write Numbers Probe. Instead on this task, the student draws the corresponding number of circles as the written number provided. For each of these assessments, the student is given one minute to complete as many as they can. To score, the number of correct items are totaled and summed. To administer, the probes are distributed to a class and the students are given scripted directions before beginning. VanDerHeyden et al. (2001), found that the probes yielded acceptable reliability for scoring and measurement of skill. Concurrent validity results

indicated that the Circle Number Probe specifically significantly correlated with the Comprehensive Inventory of Basic Skills-Revised (CIBS-R) subtests: rote counting, counts objects, and math composite score (VanDerHeyden et al., 2001). The Write Number probes did not significantly correlate with the CIBS-R subtests; however, the probe task did not directly correspond with any subtest of the CIBS-R.

Instructional Hierarchy

The use of empirically-validated interventions is essential to the Response to Intervention (RTI) process; that being said, for an intervention to be effective procedures must be appropriately matched to the needs of the student. An approach that systematically matches patterns in student responding with instructional components to intervention selection is the Instructional Hierarchy (IH; Haring & Eaton, 1978). The proposed intervention in this study will utilize three of the IH stages of learning: Acquisition, Fluency, and Generalization of skills.

The first stage of the instructional hierarchy is Acquisition. During this initial stage of learning, an individual is beginning to gain new skills, being taught new procedures and using this knowledge to solve problems. At this stage, the instructor places a high emphasis on accurate responding. It is more important for the student to be able to use the new skills correctly with consistency. In order to achieve accuracy with students that struggle learning, there are many ways to decrease difficulty and increase learning. Narrowing the curricular scope by limiting the amount of information the student is learning at once may be necessary. For example, when teaching a student to identify numbers, the instructor would most likely start with 0-9 instead of presenting 0- 20 all at once. In addition, some students may benefit from frequent feedback from the instructor and positive reinforcement to increase motivation to persevere through difficult tasks.

Once the student is consistently accurate, the next stage of the instructional hierarchy begins. The second stage is Fluency. The goal of this stage is to become fluent at the newly acquired skill. When a student learns a new skill, they are slow at applying it; however, with repeated practice, the student develops automaticity with the skill and able to apply the skill accurately and promptly.

The third stage is Generalization. Now that the student is accurate and fluent, they begin combining their skills and procedures to solve different types of problems in contexts that were outside of the context in which the skill was initially taught. Differentiation and discrimination training are used to facilitate the generalization of skills. Providing multiple examples of the learned task may increase the likelihood of a student generalizing the acquired skills (Horner, Bellamy, & Colvin, 1984). By exposing the student to multiple examples of when they can use their skills and examples of when it wouldn't be appropriate, increases their mastery of the skill and fosters generalization.

The Instructional Hierarchy supports the idea that simply learning a skill is not enough for a student to be successful. The IH requires accurate, fluent responding before acquiring the ability to execute that skill across various tasks. Once a student is capable of using their skills on different tasks and situations, the skill is considered mastered. The IH also includes instructional components which support student learning, such as drill, prompting, and reinforcement. Drill refers to repetitive practice to increase knowledge acquisition. Frequent opportunities to practice a new skill can be an effective method to strengthen the skill and help with retention. Prompting student responses by providing one or multiple cues can reduce inaccurate responses and increase student success. Incorporating reinforcement with academic instruction has been shown to increase intervention effectiveness (Freeland, & Noell, 1999).

Direct Instruction

Direct Instruction (DI) is an educational model developed by Siegfried Engelmann. The purpose of DI is to efficiently and effectively teach so that all students are able to learn the presented material. There are three main components of DI: (1) the program design identifies main ideas, rules, and strategies to be taught in a clear and concise manner, (2) organizing instruction to allow sufficient practice, progress monitoring and reteaching, (3) positive and engaging student-teacher interactions to actively engage young students throughout the lesson (Marchand-Martella, Slocum, & Martella, 2004).

When planning interventions or curriculum design, it is important to sequence skills to minimize confusion and maximize learning. Another way direct instruction maximizes learning is the use of strategically choosing or creating activities that promote generalization. In doing so, the student is able to learn more information in less time (Marchand-Martella, et al., 2004).

Scaffolding material is a method of skill sequencing. Scaffolding is layering material so that as new material is presented, the student continues to receive review and distributed practice of previous material (Bakker, Smit & Wegerif, 2015). In doing so, the student builds a foundation of simpler skills that the students are able to generalize before moving to more complex information.

During the instruction itself, the way the educator leads the lesson and the vocabulary they use is important. Engelmann and Carnine (1982) described general rules that will be utilized in the early numeracy intervention to increase clear communication. The first is the wording principle which states that educators should use the same wording throughout the lesson so the student can solely focus on learning the material. The second rule is the setup principle. To follow the setup principle, when using examples and nonexample, only the point or idea that is being taught should be shown. All other characteristics of the examples should remain the same to

highlight the idea being taught. The third rule, difference principle, suggests that educators use examples and nonexamples to avoid inaccurate generalizations.

In addition to maintaining consistent vocabulary when during instruction, direct instruction states that the way the instruction materials should also be consistent (Marchand-Martella, et al., 2004). By keeping the format in which the new information is presented the same every time, students can devote more attention to learning the information and less on new formatting.

Research indicates that students struggling in mathematics especially benefit from DI techniques. Direct Instruction's use of explicit explanations is more likely to result in learning the material correctly when compared to implicit forms of instruction (Carnine, 1991). Implicit methods of instruction, which allows students to explore the problem and solution relatively independent of teacher input. This type of mathematics instruction can lead to confusion and inaccurate procedures. DI uses explicit instruction and guided practice to reduce such problems (Marchand-Martella, et al., 2004). For the duration of guided practice, the students are given prompts and cues by the teacher to facilitate how and when to apply the newly acquired skill. While the students practice, the teacher provides feedback on their performance and corrections when necessary. The teacher is proactively monitoring students' responses in order to catch mistakes early to prevent the students from practicing incorrectly. During guided practice, the teacher pays close attention to the pace of the instruction. To avoid students becoming distracted with long pauses or frustrated when struggling to keep up, plan ahead for the pace most appropriate for the type of task.

Early Numeracy Gateway Skills and Interventions

The gateway skills for numeracy build the foundation of mathematical understanding. Before learning how to manipulate numbers, a student must first learn how to orally count,

identify numbers, count objects, and write numbers. These skills support the development of number sense which gives the student the ability to distinguish cardinality and discriminate quantity.

Oral counting is the ability to produce a correct string of numbers through speech (Threlfall, & Bruce, 2005). To accomplish this, students are taught to memorize the order of numbers, for example, counting to 10 from zero through rote practice. Oral counting also helps the student create arrangement patterns. Ginsburg (1977) stated that oral counting from 1-9 can in some cases aid in learning how to count in sequence from twenty through the higher decades. The student recognizes the repetitive pattern and is able to generalize their skills. Before beginning an early numeracy intervention that focus' on number identification, object counting, or writing numbers, the student needs to be proficient in oral counting.

After oral counting, students learn to identify number symbols. This task is taught by presenting the number symbol to the student and telling them the name of that number symbol. One type of intervention that has been used to increase number identification is flashcards. There are different methods types of flashcard interventions such as: Incremental Rehearsal, Drill and Practice, and Fold in Fold out. The purpose of a flashcard intervention is to increase the student's accuracy. A standard approach of a flashcard drill and practice is to present new stimuli and model the appropriate response to the stimuli for the student (Nist, & Joseph, 2008). Then the teacher asks the student to repeat the appropriate response while attending to the stimuli. For example, the teacher might hold up a flashcard with a "2" on it and say, "This is the number two. What number is this?" Once all the stimuli or numbers have been presented and repeated by the student, the flashcards are randomly shuffled and the numbers are shown again and giving the student an allotted amount of time to respond without providing the name of the number. If students are not able to say the name of the number within the allotted time frame, the teacher provides direct feedback to avoid unnecessary frustration for the student. However effective,

flashcard interventions are used in a one on one setting. With limited amount of instruction time, many teachers cannot afford to administer one on one interventions with every student to supplement Tier 1 curriculum.

Another effective method to teaching number identification is a taped intervention. In 2013, a small-n study investigating the use of a taped intervention found that the intervention was effective and increased the kindergarten students' ability to correctly identify numbers (Krohn, Skinner, Fuller, & Greear, 2013). During a taped intervention, students are given worksheets that correspond to an audio recording. The audio recording includes a cue, such as a beep or bell tone, to signify that the beginning of the task. Then the recording pauses for a few moments to allow the students time to attend to the visual stimuli, or number, on the worksheets, then a second auditory cue is given to signal the students to say the name of the number chorally. Next, the audio recording provides the correct name of the number, providing feedback for students. The students move to the next number on the worksheet and the process continues until the worksheet is complete.

Another early numeracy gateway skill is object counting, which evidences one to one correspondence. Object counting is a method of teaching and assessing the student's ability to associate numbers with physical items. For this task, the instructor can give the student small manipulatives (i.e. blocks, crayons) and ask them to count them out to a specific number of manipulatives.

The last early numeracy gateway skill is number writing. In order to complete class assignments in mathematics, a student needs to be able to clearly write the base numbers (i.e. 1-10). It is also crucial for the student's ability to move beyond acquisition to fluency. The more easily and quickly a student can write numbers, the rate of practice and exposure the student gets with the number combinations and complex mathematical procedures increases.

Current Early Numeracy Interventions and Technology

Over the years, researchers have been developing interventions to increase early numeracy. Although many of these interventions have shown to be effective, many are individually administered. The downside of individually administered interventions is that it can be time consuming for educators. Additionally, it can be difficult for educators to determine what intervention to use when helping a student who is struggling with mathematics. It is important to be knowledgeable as to what skill deficit to start with and which interventions are most effective.

With the increase in access to technology in the classroom, research on the effectiveness of interventions provided through technology has begun to spark interest. Burns, Kanive, and Degrande (2012) explored the effectiveness of a computer-based mathematic fluency intervention. The results suggested that students who received the intervention had considerably larger gains than students in the control group (Burns, et al., 2012). In 2013, researchers, Esoete and Raet, conducted an initial study investigating the use of computerized intervention to increase number counting and number comparison skills of kindergarteners. They found intensive interventions of short duration via computer educational games improved the students' overall mathematical functioning.

Research has begun to investigate the usefulness of technology for intervention implementation. However, there is a lack of research on scripted academic interventions.

Purpose of Current Study

Building a strong foundation in the early numeracy gateway skills in kindergarten and first grade has strong implications for future success in mathematics. Currently, little research has been done on comprehensive early numeracy interventions outside of flashcard interventions for number identification. Recently, research utilizing technology and computer-based interventions have shown promising effects. Technology-based interventions also have the

capacity to be administered to more than one student simultaneously. Group administered interventions would be beneficial to teachers with a large number of at risk students. An effective and efficient Tier 1 curriculum supplement that can be administered to kindergarten students during group instruction is needed. This exploratory study aims to examine the efficacy of an early numeracy intervention that utilizes the instructional hierarchy and direct instruction methods presented via PowerPoint to a small-group of pre-k and kindergarten students. The specific research questions are: *(1) Will the PowerPoint early numeracy intervention increase student's number identification skills? (2) Will the PowerPoint early numeracy intervention increase student's object counting skills? (3) Will the PowerPoint early numeracy intervention increase student's number writing skills? (4) Will the early numeracy skills obtained from the intervention maintain after termination of the intervention?*

CHAPTER III

METHODS

Participants and Setting

Participants included three students from two classrooms from a public school in the Midwest. Two students were in pre-kindergarten and one student was in kindergarten. Student ages ranged from 5-6 years (mean = 5 years 3 months), one student was male and two were female, and 100% of the participating students received free or reduced-price lunch. Table 1 provides demographic information of individual students in the study.

Table 1. Individual Demographic Information

| Name | Gender | Age | Grade |
|---------|--------|-----|-------|
| Ashley | Female | 5 | Pre-K |
| Emily | Female | 5 | Pre-K |
| Brandon | Male | 6 | KG |

The early numeracy intervention under investigation was provided as a Tier 2 intervention. A step in the school's RTI system was to notify parents when a student is falling behind in reading or math. In addition, parents were informed of the intervention provided to the student. Therefore, a parent notification letter was sent to inform them of the specific intervention their child would receive and listed the details of the intervention.

Approval to conduct the study to evaluate this intervention was obtained through the school principal's written permission prior to the beginning of the intervention. University institutional review board approval and written parent consent was obtained prior to analyzing and reporting results from this study. The written parent consent form included a brief explanation of the study, appropriate contact information, and clearly stated that they could withdraw consent at any time without penalty.

Materials

Numeracy Development Modules. Student responding was paced, prompted, and feedback was provided using a combination of a PowerPoint presentation and/or target skill worksheets to automate the intervention procedures. PowerPoint files referred to as Numeracy Development Modules (NDM). These NDMs target three keystone skills associated with emerging numeracy: 1) Number Identification, 2) Object Counting, & 3) Number Writing (NW). To implement these NDMs the experimenter utilized a computer capable of audio reproduction and a screen to show the academic stimuli. Responding during instruction was verbal for the number identification and object counting NDMs while the number writing NDM required a writing instrument for students to record responses on a worksheet. The number writing worksheets contain a series of boxes that contain a model of the number and a space underneath the model to either trace or write the response.

Assessment Probes. Student performance was collected across three dependent variables: 1) Number Identification, 2) Circle Number, & 3) Number Writing. For each DV, students were assessed using a probe to prompt responding. The number identification probe contained numbers 1-10 randomly arranged (see Appendix D). The circle number probe contained 20 items. On each item, between 1 & 10 dots were displayed and a series of four numbers to the right (one correct answer & three distracters) for the student to select the numerical representation of the quantity of

the dots (see Appendix E). The number writing probe consisted of 10 boxes where the student will write dictated numbers 1-10 (see Appendix F). Standard directions were used and each of the tasks were timed to completion to confer accuracy data.

Procedures

General procedures. School psychology graduate students implemented all procedures and collected all assessment data in the students' intervention rooms on consecutive school days depending on availability. The early numeracy intervention sessions were completed in the morning and assessment data were collected at least 30 minutes after the conclusion of the intervention. The classroom teachers were consulted about what times were preferred for the intervention to take place.

Assessment Procedure. Assessment data were collected for all of the students each day using a packet of one to three probes (one number identification probe, one circle number probe, and one number writing probe). Researchers sat down with each student, placed a target skill probe in front of them and read a standardized set of directions. For each probe, the researcher recorded how much time it took for the student to complete all of the items on the probe. When the student failed to respond to an item within five (s) they were told to go to the next item (the item was counted as incorrect). Baseline data were collected across three consecutive school days. Assessment data were collected individually, occurred throughout the duration of the study, and were collected at least 30 minutes after the NDM had been completed. A week after the final day of intervention implementation, a maintenance datum point was collected for each target skill.

Intervention Procedures. The NDM targeted three keystone skills associated with emerging numeracy: 1) Number Identification, 2) Object Counting, & 3) Number Writing (NW) across a group of three pre-kindergarten and kindergarten students. The researcher led the

intervention sessions by first starting the PowerPoint presentation of the target skill. Once the NDM was started the primary goal of the researcher was to ensure active and accurate responding by observing student responding and providing feedback concerning participation. Intervention procedures began once baseline data were stable; the researchers introduced and trained the students how to participate in and engage with the NDM targeting number identification intervention. The researcher implemented the NDM until the group average met or exceeded the criteria or growth became stabilized. Once the criterion was met for Number Identification, the group was moved to Object Counting and then lastly Number Writing. When the group average met criteria across all skills the intervention was stopped.

Each of the NDMs were automated using PowerPoint. The NDMs provided students with paced exposure to target skills with immediate corrective or performance feedback. For the Number Identification NDM teaching slides consisted of review of previous material, teaching new material, paced practice with feedback, and combined practice of previous and new material. Each slide consisted of the presentation of numbers, a bell to cue student response and then an audio recording to provide the correct number name. During the teaching and review sections, slides had one number on them with individual prompts; each slide's duration was approximately three s. For paced practice with feedback sections, slides showed a random array of newly taught numbers with visual cues and audio feedback. During combined practice, all previously presented numbers and newly learned numbers were practiced with paced practice. The set of numbers were arranged in random order. The Number Identification NDM introduced numbers 1-10 in groups of five. The Number Identification NDM consisted of 37-40 PowerPoint slides. Each section's duration was 1-1.5 min. Each group of numbers was practiced once a day for four days before introducing the next group of numbers. Each day, the Number Identification module reviewed previously learned numbers, then practiced new numbers, and concluded by practicing all presented numbers.

For the Object Counting NDM, slides consisted of guided counting practice and instructions for independent practice. Object Counting NDM consisted of 16 slides. Together, the duration of the guided practice portion was a total of four min and the independent practice was also approximately four min. During the guided practice section of the NDM, the slides presented a varied amount of stars to be counted. At the start of each session, the slide would say, *“Today we are going to work on counting. Watch me count the stars... (then counts each one as it is highlighted on the slide). Okay, now let’s count together.”* After the guided practice, the second section of the intervention begins by slides saying, *“Now you count the stars. Ready, go.”* On the following slides, the students are meant to count the number of stars out loud as each star becomes highlighted, one at a time. At the end of each slide, the answer of how many stars was said to provide feedback to students. The third section of the intervention uses paced independent practice. To do this the students were given worksheets. The worksheets contained seven items each. On each item, between 1 & 10 dots were displayed and a series of four numbers were placed to the right of the dots (one correct answer & three distracters) for the student to select the numerical representation of the quantity. The interventionist says, *“Now look at your papers. There are rows of different numbers. Next to them are groups of stars. Count how many stars are in the group, then circle correct number of stars. Do the first problem and when you are done, hold your pencil up and I will check your answer. Ready? Go.”* The interventionist would provide corrective feedback and have students correct any mistakes. The students completed each item on the worksheet one at a time with corrections and feedback. The fourth sections use independent practice. The students were given corrective feedback and then instructed to fix mistakes. For the Number Writing NDM, slides consisted of a task introduction with opportunities to practice, audio recording of paced random numbers for students to write, and visual feedback. The Number Writing NDM consisted of 27 intervention slides. The Number Writing NDM intervention sessions included review of previous material, teaching new material, paced practice with feedback, and combined practice of previous and new material. Each section

of the intervention was between one and one and a half min duration. Numbers 1-10 were practiced in groups of five. At the beginning of each intervention session, students were given a packet of probes corresponding with the slides. The first section's probe consisted of the two rows of numbers in sequential order in bold print and directly underneath the bold printed numbers were the numbers in a dashed line print for the student to trace. The second section's probe consisted of the same format as the first; except the numbers were arranged in random order. The third section's probe contained rows of blank boxes for students to write the numbers presented in random order by the audio recording. On the PowerPoint, a number would be presented and the slide would say the number, "*Here is a 2. Write a 2 in the first box.*" After instructions finished, the student wrote the number without tracing. Feedback was given throughout this section. Each group of numbers was practiced once a day for four days before introducing the following group of numbers to write. Each day, the Number Writing NDM followed the same format, reviewing previously learned numbers, teaching new numbers, and concluded with practicing all presented numbers.

Experimental Design, Dependent Measure, & Scoring Procedures

A multiple probe design (Cuvo, 1979) was used across three skills (Number Identification, Object Counting, and Number Writing) to evaluate the effect of the NDMs in a small group setting. Given the purpose of the study to investigate the overall impact of the NDMs with a small group, group-wide averages of the dependent variables were used to guide decision making (e.g., phase changes) with scores plotted on a time series graph and visual analysis used to interpret the data. To supplement the visual analysis of the group data, individual data were also examined. To analyze individual student data, within-phase mean comparisons were used to provide descriptive data about student growth. The dependent measures used in the study included accuracy of digits correct (DC). These data resulted from student performance on

experimenter constructed probes using CBM procedures across Number Identification, Circle Number, and Number Writing measures.

Procedural Integrity & Interscorer Agreement

An independent observer was in the classroom and collected procedural integrity data during eight of the 24 intervention sessions (33%) and nine of the 25 assessment sessions (36%). During both the assessment and intervention sessions, the independent observer recorded the presence or absence of experimenter behaviors located on the implementation guidelines and checklist. The experimenter implemented 100% of the steps during each observation during both conditions. In addition, an independent rater scored the DC on 33% of the assessment sheets. Interscorer agreement for DC was calculated by dividing the number of agreements by the number of agreements, plus disagreements and then multiplied by 100. Across assessment sheets, average interscorer agreement on DC was 100%.

CHAPTER IV

RESULTS

A multiple probe design (Cuvo, 1979) was used across three skills (Number Identification, Object Counting, and Number Writing) to evaluate the effect of the NDMs in a small group setting. Figure 1 displays the group's average accuracy data across sessions and probe phases. These data resulted from student performance on experimenter constructed probes using CBM procedures across Number Identification, Circle Number, and Number Writing measures. Specifically, percent of accuracy for each skill was used as the dependent variable.

Baseline data for Number Identification is flat with no clear trend, whereas the data for Circle Number and Number Writing have a slight upward trend. The difference in baseline data across skill phases was likely the result of carry-over affects due to students' increasing Number Identification knowledge. Upon the introduction of each NDM, the group average data for each of the early numeracy skills show an immediate increase in both level and trend.

On average, student performance on the Number Identification probes increased from an average of 14% accuracy of DC in baseline phase to 77% accuracy during the NDM intervention phase. On the maintenance assessment, the average increased to 83% accuracy of DC. The nine Number Identification intervention sessions were conducted over nine school-days and were estimated to take approximately seven minutes per day. This resulted in a total duration of

roughly 63 min of instructional time on Number Identification. A visual analysis of individual student data showed that all three students made gains, from initial baseline assessment to final maintenance assessment, ranging from 60% to 80% accuracy increase of DC.

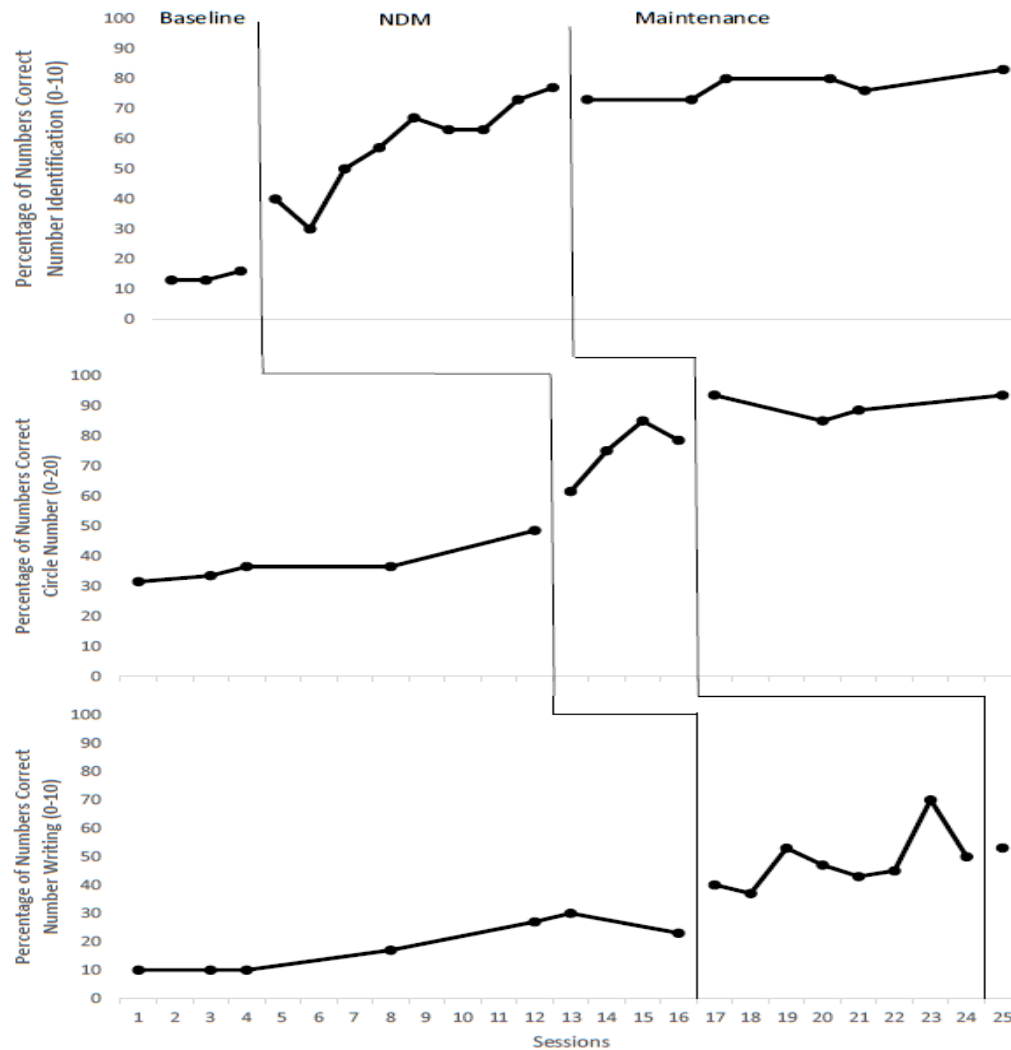
On average, student performance on the Circle Number probes increased from 37.3% accuracy in baseline phase to 78.5% accuracy of DC during the NDM intervention phase. On the maintenance assessment, the average increased to 93.5% accuracy of DC. The four Circle Number intervention sessions were conducted over four school-days and were estimated to take approximately 10 min per day. This resulted in a total duration of roughly 40 min of instructional time on the skill Object Counting. A visual analysis of individual student data showed that all three students made gains, from initial baseline assessment to final maintenance assessment, ranging from 40% to 95% accuracy increase of DC.

On average, student performance on the Number Writing probes increased from an average of 18.1% accuracy in baseline phase to 50% accuracy during the NDM intervention phase. On the maintenance assessment, the average accuracy increased to 53%. The eight Number Writing intervention sessions were conducted over eight school-days and were estimated to take approximately 10 min per day. This resulted in a total duration of roughly 80 min of instructional time on Number Writing skills. A visual analysis of individual student data showed that all three students made gains, from the initial baseline assessment to maintenance assessment, ranging from 30% to 60% accuracy increase of DC. The intervention was discontinued prior to meeting the target goal of 80% accuracy due to slow growth rate likely attributed to the more complex nature of Number Writing skill.

Maintenance data was collected for Number Identification and Object Counting skills. The group average increased slightly on Number Identification skills, while their Object Counting skills maintained after instruction switched to the next skill. One week after the conclusion of the

NDMs, a maintenance datum was collected across all probes. Overall, the group average data indicated each skill maintained after all NDM instruction ceased.

Figure 1. Group Average Data



To supplement the visual analysis of group and individual student data, within-phase averages were compared to provide descriptive data about student growth across baseline, intervention, and maintenance phases (Poncy and Skinner 2011). Since the NDM was investigating its effect as a small-group intervention phase change decisions were made based on group averages. Therefore, individual student graphed data may or may not exactly match phase

change decisions if NDM was implemented individually. Since phase changes were made at the group level, data patterns observed from the individual graphs may show phase changes that are not conducive to supporting experimental control. Table 2 provides within phase average comparison group data.

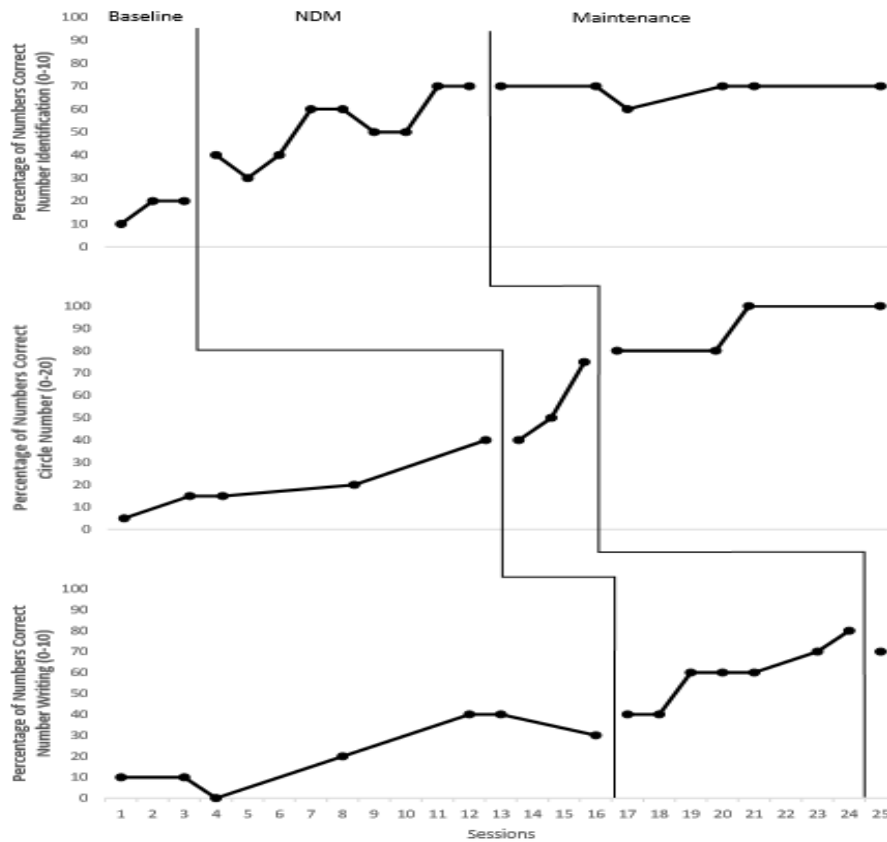
Table 2. Within phase average comparison of the group's data

| Skill/Probe Set | Baseline | Intervention | Maintenance | Baseline-Maintenance Growth |
|-----------------------|----------|--------------|-------------|-----------------------------|
| Number Identification | 14% | 55.4% | 77.4% | 63.4% |
| Circle Number | 37.3% | 75% | 90.1% | 52.8% |
| Number Writing | 18.1% | 48.1% | 53% | 34.9% |

Brandon

Visual analysis of the accuracy data indicated significant results. Figure 2 displays Brandon's individual probe accuracy data. After all three phase changes, a noticeable increase in performance was seen after implementation of the NDM.

Figure 2. Brandon's individual accuracy data



To provide additional support to the visual analysis results, Table 3 provides Brandon's within phase average comparison data. When examining the phase-averages, Brandon's Number Identification accuracy increased 51.6% from baseline phase to maintenance phase. On Circle Number, Brandon's accuracy increased by 71% from baseline to maintenance. On Number Writing, Brandon's accuracy increased by 48.6% from baseline to maintenance.

Table 3. Within phase average comparison of Brandon's accuracy data

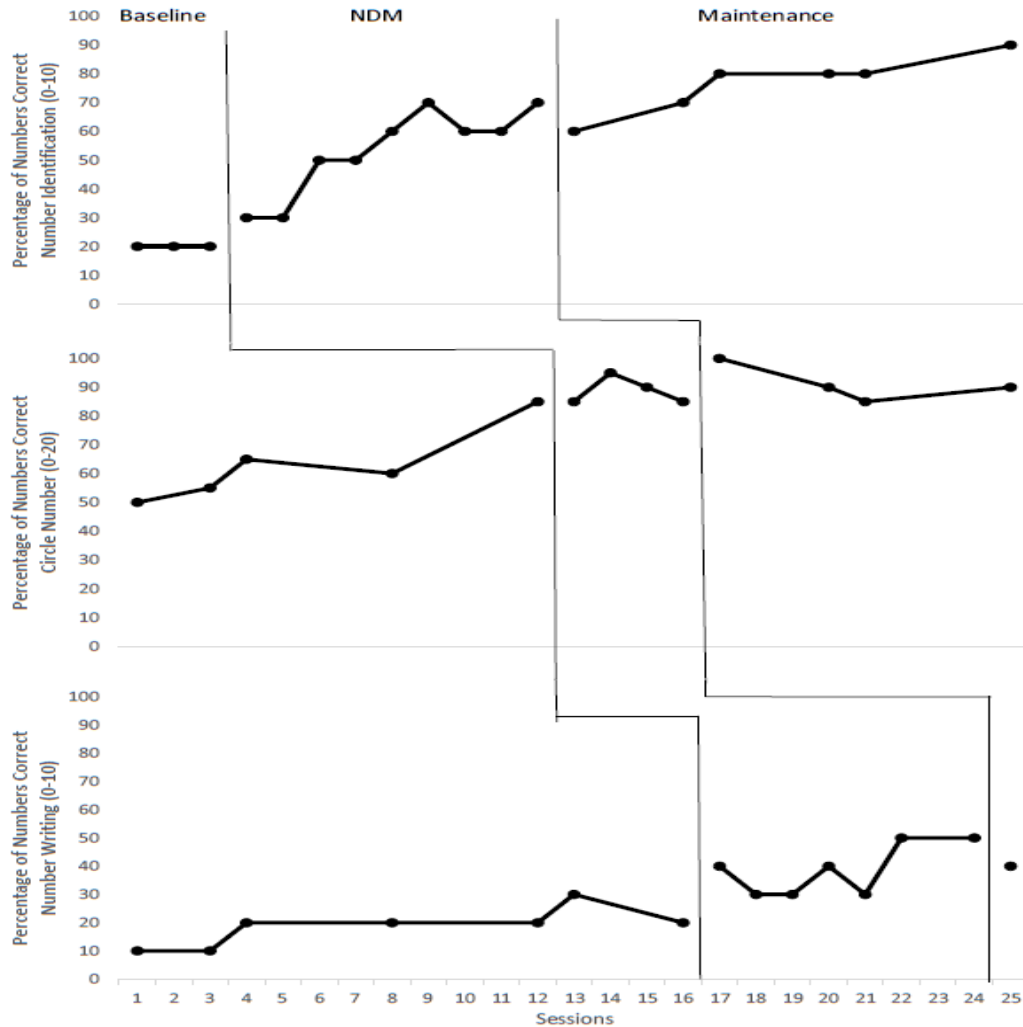
| Skill/Probe Set | Baseline | Intervention | Maintenance | Baseline-Maintenance Growth |
|-----------------------|----------|--------------|-------------|-----------------------------|
| Number Identification | 16.7% | 52.2% | 68.3% | 51.6% |
| Circle Number | 19% | 55% | 90% | 71% |
| Number Writing | 21.4% | 58.6% | 70% | 48.6% |

When analyzing Figure 2 and Table 3 together, the results demonstrate an increase in skill development for the three skill areas of the NDM. In addition, the NDM intervention was shown to be most effective in increasing his accuracy on the Circle Number probe assessments. However, Brandon's Circle Number data shows a slight increase over baseline, which may indicate a portion of his skill growth was impacted by his increase in Number Identification skills.

Ashley

Visual analysis of the accuracy data indicated significant results. Figure 3 displays Ashley's individual probe accuracy data. After all three phase changes, a noticeable increase in performance was seen after implementation of the NDM.

Figure 3. Ashley's individual accuracy data



To provide additional support to the visual analysis results, Table 4 provides Ashley's within phase average comparison data. When examining the phase-averages, Ashley's Number Identification accuracy increased 56.7% from baseline phase to maintenance phase. On Circle Number, Ashley's accuracy increased by 28.3% from baseline to maintenance. On Number Writing, Ashley's accuracy increased by 21.4% from baseline to maintenance.

Table 4. Within phase average comparison of Ashley's accuracy data

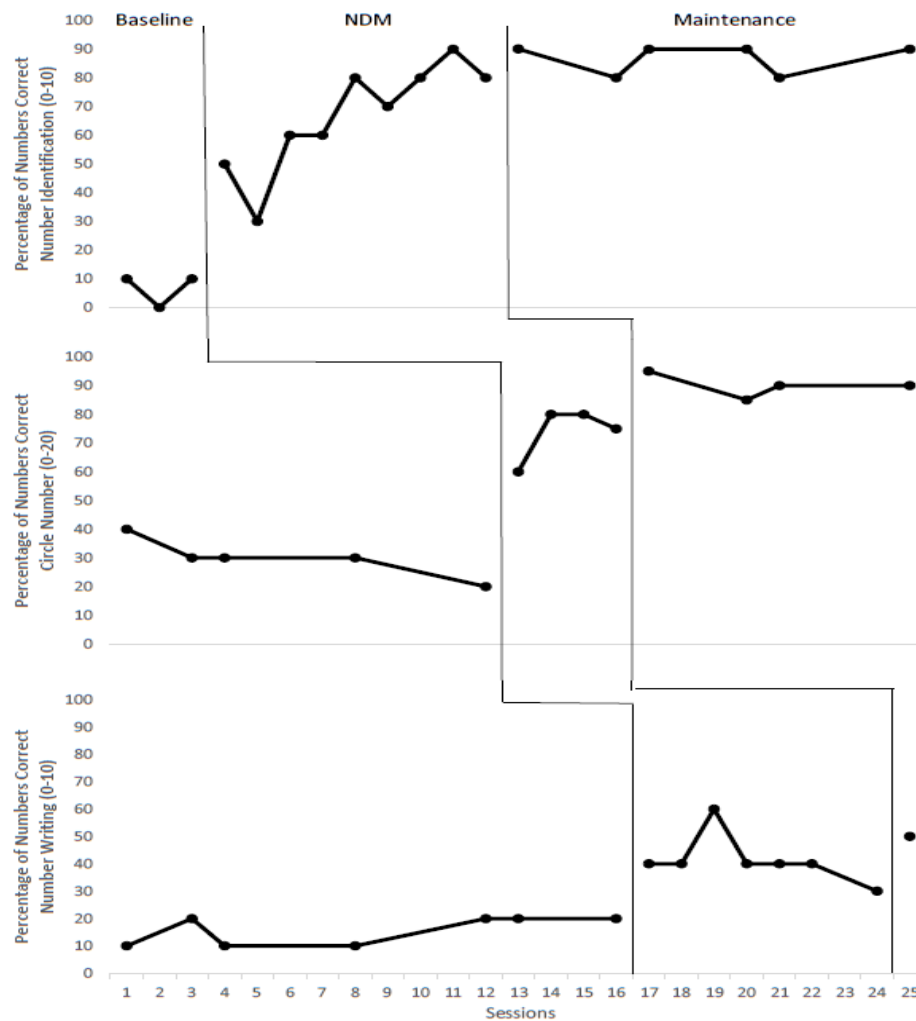
| Skill/Probe Set | Baseline | Intervention | Maintenance | Baseline-Maintenance Growth |
|-----------------------|----------|--------------|-------------|-----------------------------|
| Number Identification | 20% | 53.3% | 76.7% | 56.7% |
| Circle Number | 63% | 88.8% | 91.3% | 28.3% |
| Number Writing | 18.6% | 38.6% | 40% | 21.4% |

When analyzing Figure 3 and Table 4 together, the results demonstrate an increase in skill development for the three skill areas of the NDM. The Number Identification portion of the NDM intervention was shown to be most effective in increasing her accuracy skills. Furthermore, Ashley's increase in Number Identification accuracy had carry-over effects on her performance on Circle Number probe, which suggests generalization. For example, Ashley may have had rudimentary object counting skills, but did not have number recognition at baseline. Once Ashley was able to correctly identify numbers 1-10, she may have been able to carry over that knowledge and apply it to Circle Number.

Emily

Visual analysis of the accuracy data indicated significant results. After all three phase changes, a noticeable increase in performance was seen after implementation of the NDM.

Figure 4. Emily's individual accuracy data



To provide additional support to the visual analysis results, Table 5 provides Emily's within phase average comparison data. When examining the phase-averages, Emily's Number Identification accuracy increased 56.7% from baseline phase to maintenance phase. On Circle Number, Emily's accuracy increased by 28.3% from baseline to maintenance. Data indicates Emily's growth on Number Identification did not independently generalize to the other skills. On Number Writing, Emily's accuracy increased by 21.4% from baseline to maintenance.

Table 5. Within phase average comparison of Emily's accuracy data

| Skill/Probe Set | Baseline | Intervention | Maintenance | Baseline-Maintenance Growth |
|-----------------------|----------|--------------|-------------|-----------------------------|
| Number Identification | 6.7% | 66.7% | 86.7% | 80% |
| Circle Number | 30% | 73.8% | 90% | 60% |
| Number Writing | 15.7% | 41.4% | 50% | 34.3% |

When analyzing Figure 4 and Table 5 together, the results demonstrate an increase in skill development for the three skill areas of the NDM. The Number Identification portion of the NDM intervention was shown to be most effective in increasing her accuracy skills.

Summary

Visual analysis of the data indicates that baseline data across each of the three skills were either stable or stable with a slight increase. The NDM intervention phase data showed a stable and increasing trend upon introduction of the NDM for each skill. Although, due to the skill's greater complexity, Number Writing skills increased at a slower rate. Maintenance data was collected for Number Identification and Object Counting skills with both skills maintaining after instruction switched to the next skill. One week after the conclusion of the NDMs, a maintenance datum was collected across all probes. The group average data indicated the students' early numeracy skills maintained or increased after one week. Data converge to support that the use of the NDMs resulted in the acquisition of early numeracy skills for the group of pre-kindergarten and kindergarten students.

CHAPTER V

DISCUSSION/CONCLUSION

The purpose of this study was to examine effectiveness of a scripted intervention that utilizes the Instructional Hierarchy framework and direct instruction strategies via PowerPoint at increasing early numeracy skills when administered to a small group of pre-kindergarten and kindergarten students. The study sought to answer the following questions: (1) Will the PowerPoint early numeracy intervention NDM increase students' number identification skills? (2) Will the PowerPoint early numeracy intervention NDM increase students' object counting skills? (3) Will the PowerPoint early numeracy intervention NDM increase students' number writing skills? (4) Will the early numeracy skills obtained from the NDM intervention maintain after termination of the intervention?

Competence in basic numeracy skills is critical for early elementary students to succeed in more advanced mathematical tasks. An increasing number of schools are choosing to use Response to Intervention (RTI) as an approach to providing support to academically at-risk students. Within RTI, tier one instruction provided during whole group instruction is the foundation of academic success. However, not all students respond to the core curriculum and make appropriate growth. For teachers and school staff to effectively support at-risk students, research-based interventions are required which are often done either in small groups or individually.

Instructional procedures used during intervention sessions can greatly impact student learning rates. Specifically, it is important that intervention selection is matched to patterns in student responding. A model that supports this practice is the Instructional Hierarchy (IH; Haring & Eaton, 1978). The IH breaks down the learning process to defined stages (e.g., acquisition, fluency, generalization) and provides instructional components (e.g., demonstration, corrective feedback, drill) that should be used to remediate associated deficits. Another set of instructional procedures that have been supported in the literature is direct instruction. Direct instruction is an educational model that uses scaffolding, clear communication and presentation, and prompt feedback and support. Direct Instruction's use of explicit instruction and guided practice is an effective method of increasing accurate learning (Carnine, 1991).

Over the years, researchers have been developing interventions to increase early numeracy skills. Although many of these interventions have been shown to be effective, oftentimes they are individually administered resulting in services that are time consuming for teachers and costly for schools. The purpose of report on a study that experimentally validated the integration of PowerPoint technology with direct instruction procedures in a small group setting to increase early numeracy skills with pre-k and kindergarten students. Currently, little research has been done on comprehensive, scripted early numeracy interventions that can be administered in small-group settings.

Results show evidence the NDM increased all three students' number identification, object counting, and number writing skills. More specifically, the students' accuracy significantly increased with approximately 190 min of instructional time. The maintenance data indicated the skills gains remained stable or further increased after the NDMs were discontinued.

A strength of this study is that the students were limited to pre-k and kindergarteners. The skill level of each of the students were extremely similar, with the exception of Ashley's higher

skill on the Circle Number task. These factors provided a relatively homogenous sample. In addition, the early numeracy intervention was conducted at a consistent time and the environment was limited to two settings.

Furthermore, there are very few research-based early numeracy interventions available for students before first grade. This study has shown NDM's effectiveness with pre-k and kindergarten students within a small-group setting. By utilizing PowerPoint's technology to run the intervention, teachers' and interventionists' time and effort can be focused on student participation and responding. Prompt feedback and corrections are critical to increasing accurate learning.

Practical Implications

School psychologists are constantly striving to provide the most effective and efficient service delivery for all students with the universal goal to prevent and remedy skill deficits. The technology and procedures in the Numeracy Development Modules (NDM) can be used with small groups of early childhood students who have skill deficits with early numeracy skills. This is important as there are relatively few studies that have validated interventions in this area. In addition, the NDM requires less than 15 min a day to fit into busy school schedules. For students needing additional support to meet learning needs, the NDM could potentially be administered on a classroom computer individually with support from the teacher. The NDM's use of technology to administer the academic instruction allow teachers to focus on student responding; reinforcing accurate responses and correcting inaccurate responses before inaccurate learning occurs.

Limitations

A limitation of this study is that the sample size was small and the students were from the same school and socio-economic status. These student factors likely hinder the ability for generalization to the population as a whole.

Another limitation of this study is the primary researcher cannot conclusively state the students' sole early numeracy instruction came from the researcher's intervention. For example, school staff may have continued to teach early numeracy skills in the classroom. Therefore, the study's results were potentially impacted by supplementary instruction.

In addition, the severity of the students' distractibility could have impacted the results. Frequent redirections were required to keep students' attention on the early numeracy intervention. The school's campus-wide behavior reward system was utilized at the conclusion of each intervention session, which consisted on behavior specific verbal praise and a token sticker from students' teachers.

Furthermore, due to the students' low accuracy at baseline, the researcher targeted accuracy and made phase change decisions based on accuracy data. Therefore, fluency was not directly targeted or analyzed.

Future Research

Future studies may further examine NDM's effect on skill fluency. To further develop numeracy skills, the item set could be extended from numbers 1-10 to numbers 1-20. Recommendations to replicate the study with a larger sample size may increase generalization. Future research studies might further investigate the effectiveness of this early numeracy intervention with a structured behavioral intervention component. Due to pre-kindergarten and kindergarten students' developmental factors, such as decreased attention-span, and increased distractibility and active nature, setting up a clear behavioral intervention piece before introducing the early numeracy intervention may reduce problematic behaviors.

Future studies might compare differences of this early numeracy intervention's efficacy between pre-kindergarten and kindergarten class-wide implementation versus small-group. In addition, future studies might include older students with low early numeracy skills. Comparing

the current intervention against other types of early numeracy interventions may provide important information regarding effective procedures based on different populations, such as age range or skill level.

Future studies might further investigate the efficacy of this early numeracy intervention with regards to individuals with a Specific Learning Disability in the area of mathematics. Studies may investigate whether older students in grades higher than kindergarten with early numeracy skill deficits also benefit from this early numeracy intervention.

Conclusion

Over the years, researchers have been developing interventions to increase early numeracy skills. Although many of these interventions have been shown to be effective, oftentimes they are individually administered resulting in services that are time consuming for teachers and costly for schools. Presently, insufficient research has been completed on comprehensive, scripted early numeracy interventions for pre-k and kindergarten small-groups. The purpose of this paper is report on a study that experimentally validated the integration of PowerPoint technology with direct instruction procedures and utilization of the Instructional Hierarchy in a small group setting to increase accuracy of early numeracy skills with pre-k and kindergarten students. A multiple baseline design was used to validate a technology-based intervention across three early numeracy skills with a small group of pre-k and kindergarten students. Furthermore, this study shows support for the use of technology in the classroom to implement interventions. Through NDM's technological format, teachers and interventionists would be able to provide additional supports to more at-risk students with low early numeracy. The growing spread of schools implementing the Response to Intervention (RTI) model are in need of evidence-based interventions. There are few early numeracy interventions which can be implemented in small-groups, rather than individually, and requires less than 15 min a day to fit into busy school schedules. This study

provides evidence that Numeracy Development Modules (NDM) would be a useful tool for teachers and interventionists to use with at-risk pre-k and kindergarten students. School psychologists are constantly striving to provide the most effective and efficient service delivery for all students with the universal goal to prevent and remedy skill deficits. The findings from this study provides empirical evidence that the NDM, a comprehensive, scripted intervention can be used across early numeracy skills in a small-group setting.

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APPENDICES

Appendix A: Parent Permission Form

PARENT/GUARDIAN PERMISSION FORM OKLAHOMA STATE UNIVERSITY

PROJECT TITLE: Using Technology with Pre-K and Kindergarten Students to Increase Early Numeracy Skills

| | | |
|-----------------------|---|---|
| RESEARCHER(S): | Sheridan Smith, MS Graduate Student Oklahoma State University | Brian Poncy, PhD Professor in School Psychology Program Oklahoma State University |
|-----------------------|---|---|

PROCEDURES OF PROJECT:

In an effort to ensure that your child is on grade level in the area of mathematics, Indian Camp Elementary uses a Response to Intervention (RtI) model of tiered supports. Under this instructional model, three levels (called "tiers") of educational support and intervention are provided to students based on their instructional needs. Students performing below grade level will be provided an individualized intervention to help them become proficient in mathematics.

During the last school year, screening data indicated that your child scored within the At-Risk range in mathematics and would benefit from instructional supports in addition to the core curriculum. The intervention that was provided for your child was called the Numeracy Development Modules (NDM), which includes evidence-based instruction on three early numeracy skills: number identification, object counting, and number writing. To measure your child's growth in relation to these supports, progress monitoring data was collected to ensure your child was benefiting from the intervention. The intervention increased your child's mathematics skills and the interventionist and researchers wish to share the results of the intervention with educators and academic researchers.

PURPOSE OF PROJECT:

By sharing the results of the mathematics intervention your child received during the previous school year at Indian Camp Elementary, the researchers will be able to help other teachers and schools in need of a mathematic intervention for kindergarten students.

RISKS OF PARTICIPATION:

There are no known risks associated with this project.

BENEFITS OF PARTICIPATION:

Your child benefited from receiving the mathematic intervention during the previous school year, therefore, there are no further direct benefits to you or your child. However, distribution of the intervention results will be beneficial to other students, teachers, and schools.

CONFIDENTIALITY:

In order to maintain the confidentiality of your child's intervention materials and data obtained from this study, your child's name will not be listed on any shared documents. The intervention

materials will be in a locked box that only the primary researcher will have access. Electronic data will be stored on a password-protected computer with password access only available to the principal researchers and researchers working on this project. Any written results will discuss general trends across all students and any individual data shown will not include any identifiable information. Your participation will not be shared with anyone other than the principal researchers.

COMPENSATION:

No monetary compensation is offered for participation in the study. The benefits provided by the study are explained above.

CONTACTS:

If you have any questions with regard to you or your child's involvement in this study please contact us at your earliest convenience:

Sheridan Smith
(918) 693-5242
sheridan.smith@okstate.edu

Brian Poncy, Ph.D.
(405) 744-4808
brian.poncy@okstate.edu

If you have questions about your rights as a research volunteer, you may contact Dr. Hugh Crethar, IRB Chair, 223 Scott Hall, Stillwater, OK 74078, (405) 744-3377 or irb@okstate.edu.

PARTICIPANT RIGHTS:

I understand that my child's participation is voluntary, that there is no penalty for refusal to participate, and that I am free to withdraw my permission at any time.

CONSENT DOCUMENTATION:

I have been fully informed about the procedures listed here. I am aware of what my child and I will be asked to do and of the benefits of my participation. I also understand the following statements:

I have read and fully understand this permission form. I sign it freely and voluntarily. A copy of this form will be given to me. I hereby give permission for my child _____ participation in this study.

Signature of Parent/Legal Guardian

Date

Appendix B: IRB Approval



Oklahoma State University
University Research Compliance
Institutional Review Board

223 Scott Hall
 Stillwater, OK 74078
 Email: irb@okstate.edu
 Phone: 405.744.3377
 Fax: 405.744.4335
 Website: irb.okstate.edu

Application for Review of Human Subjects Research

Pursuant to [45 CFR 46](#)

Name of Main PI IRB Number
Office Use Only Office Use Only

Part 1: Administrative Information

| | |
|--|--|
| Title of Project | Using Technology to Improve Pre-K and Kindergarten Early Numeracy Skills |
| Proposed Start Date of Project | Feb 1, 2017 |
| Name of Main PI | Sheridan Christine Smith |
| College | Education |
| Department/School | School of Applied Health & Educational Psychology |
| Address | 1000 N North Star Dr Apt 28, Stillwater, OK, 74075 |
| Phone Number | 918.693.5242 |
| E-mail Address | sheridan.smith@okstate.edu |
| Position/Rank | Graduate Student |

| | |
|-------------------|---|
| Name of Advisor | Brian Poncy, Ph.D. |
| College | Education |
| Department/School | School of Applied Health & Educational Psychology |
| Address | 420 Willard Hall, Stillwater, OK 74078 |
| Phone Number | 405.744.4808 |
| E-mail Address | brian.poncy@okstate.edu |

Revision: 06.31.16

Page 1 of 20

Application for Review of Human Subjects Research

Pursuant to 45 CFR 46

Name of Main PI

Sheridan Christine Smith

IRB Number

Office Use Only

Office Use Only

Co-PIs and other research team members information:

| Name | E-Mail | Affiliation | College | Department | Organization | State/Country |
|--------|--------|-------------|---------|------------|--------------|---------------|
| | | Select One | | | | |
| Add | | | | | | |
| Remove | | | | | | |

Unnamed additional personnel information:

| Position | Affiliation | Human Subject Training | Training Description |
|----------|-------------|------------------------|----------------------|
| | | | |
| Add | | | |
| Remove | | | |

Is this research being funded by an external funding agency? ☐ Yes ☒ No

Part 2: Determination of [Research](#)

| | | |
|---|-----|--|
| Will the data be obtained in a systematic manner? | Yes | |
| Will the intent of the data collection be for the purpose of contributing to generalizable knowledge (the results of the activity are intended to be extended beyond a single individual or an internal program to be widely applicable). | Yes | |

Part 3: Determination of [Human Subject](#)

| | | |
|--|-----|--|
| Does the research involve obtaining information about LIVING individuals? | Yes | |
| Does the study involve intervention or interaction with a "human subject?" | Yes | |
| Does the study involve access to identifiable private information? | Yes | |

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| | | |
|--|-----|---|
| Are data <u>received</u> by the investigator with identifiable private information? | Yes | ▼ |
| Are the data coded such that a link exists that could allow the data to be reidentified? | Yes | ▼ |
| Is there a written agreement that prohibits the PI and his/her staff access to the link? | No | ▼ |

Part 4: Determination of [Review Level](#)

While the IRB is ultimately responsible for deciding the review level of research, investigators are asked to make an initial determination of the appropriate processing category. This section will help you determine the review level.

Does the research pose more than [minimal risk](#) to the subjects?

- ☐ Yes
☒ No

Does the study involve any of the following?

- ☐ Procedures subject to FDA Regulation (ex. medical devices, drugs, biological products, etc.)
☐ [Prisoners, Felons, Wards of the State, or Institutionalized Individuals](#)
☐ Collection of data about subjects' behavior involving illegal conduct such as drug and alcohol use, where the subjects are identifiable.
☒ No, none of the situations listed above apply.

Part 4.1: Determination of [Exempt Status](#)

Please select the category that best applies to your research, if any, from the list below.

Category 1: Educational Settings

- ☐ Research conducted in established or commonly accepted educational settings including but not limited to schools and colleges. It may include other sites where educational activities regularly occur.
☐ The research will involve only normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

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Category 2: Educational Tests, Surveys, Interviews, Public Behavior Observation

- ☐ The research will only involve the use of education test(s) (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior.
- ☐ If research will involve children, the procedures are limited to the use of educational test(s) or observation of public behavior where the investigator will NOT participate in the activities being observed.
- ☐ The information obtained from educational test(s), survey procedures, interview procedures or observation of public behavior will be recorded in such a manner that human subjects CANNOT be identified, directly or through identifiers linked to the subjects.
- ☐ Any disclosure of the human subjects' responses outside of the research could NOT reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.*

*Note: Risks of criminal or civil liability, or of damage to financial standing, employability, or reputation can be dependent on the context of the research and are determined by the IRB staff based on experience, past precedent and benchmarked best practices. The IRB staff welcomes the input of investigators in determining the possibility of such risks, but if there is reasonable doubt about whether or not the criteria applies, the research is not exempt.

Category 3: Educational Tests, Surveys, Interviews, Public Behavior Observation of Public Officials

- ☐ The research will involve only the use of educational test(s), survey procedures, interview procedures or observation of public behavior **AND** the human subjects are elected or appointed public officials or candidates for public office. This applies to senior officials such as mayors or school superintendents rather than a police officer or teacher.
- ☐ If research will involve only the use of educational test(s), survey procedures, interview procedures or observation of public behavior **AND** federal statutes require without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and after.

Category 4: Existing Data, Documents, and Specimens

- ☐ The research will involve only the collection or study of *existing* data, documents, records, pathological specimens, or diagnostic specimens.
- ☐ The sources of the existing data, documents, records or specimens are publicly available **OR** the information will be recorded by the investigator in such a manner that subjects cannot be readily identified either directly or through a code linked to them.

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Category 5: For Public Benefit or Service Programs (Federal Only)

The project is a research or demonstration project conducted by or subject to the approval of a federal department or agency heads, and are designed to study, evaluate, or otherwise examine

- ☒ (i) public benefit or service programs, (ii) procedures for obtaining benefits or services under those programs, (iii) possible changes in or alternatives to those programs or procedures, or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

Category 6: Taste and Food Quality and Consumer Acceptance Studies

The research involves only a taste and food quality evaluation or a food consumer acceptance study in which (i) wholesome foods without additives will be consumed OR (ii) food will be consumed that contains a food ingredient, agricultural chemical, or environmental contaminant

- ☐ that is at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

- ☐ If your research does not fit into any of these exempt categories, please check this box.

Part 5: Study Design, Methods & Procedures

Data Source(s): Please select all categories that apply to your research project.

- ☐ Active Data Collection - Social, Behavioral, or Educational
☐ Active Data Collection - Use of human biological materials or physiological data, use of physiological or biomedical devices, drugs, biologics, or chemical agents
☒ Existing Data
☐ Existing Human Biological Materials

Please briefly state the purpose of the project and include all research questions, hypotheses, and/or aims to be evaluated. Please include a brief summary of related research findings in a language understandable to someone who is not familiar with your area of study.

The school involved in this proposed study is in a district that uses a Response to Intervention (RTI) model to identify students who are at-risk for academic difficulties and need increased level of support, as well as to determine eligibility for special education services for the category of a Specific Learning Disability. As part of the RTI process, students are screened on academic skills three times a year to determine if they are responding to the tier 1, general education curriculum.

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Screening data has indicated that some Pre-K and Kindergarten students fell within the Some Risk or At-Risk range in mathematic skills. The school decided that these students would benefit from instructional supports in addition to the core curriculum. The intervention provided to the students was called the Numeracy Development Modules (NDM) which includes instruction on three early numeracy skills: number identification, object counting, and number writing. The intervention uses evidence-based methods to efficiently and effectively teach the three early numeracy skills. This early numeracy intervention utilizes the instructional hierarchy and direct instruction methods presented via PowerPoint. In order to measure the student's growth in relation to these supports, interventionist collected frequent progress monitoring data to ensure the students were gaining skills and benefiting from the intervention. The Primary Investigator provided the intervention to the students as a service project. The Primary Investigator worked as an interventionist and external academic coach to the school. The intervention was provided to the students for educational purposes with no intention of using it outside of the educational setting. After analyzing the data and seeing positive results, the Primary Investigator would like to use the results for dissertation, as well as publication and a presentation.

Please briefly describe how this study will contribute to existing knowledge in the field.

Currently, little research has been done on comprehensive, scripted early numeracy interventions that can be administered in small-group settings. Building a strong foundation in the early numeracy gateway skills in kindergarten has strong implications for future success in mathematics. Therefore, it is important to provide effective educational interventions to teachers. With an increase of technology in schools, this intervention utilizes basic technology which would be time and cost effective for schools.

How will the results of this project be used? (e.g. Presentation? Publication? Thesis? Dissertation?)

This service project study's results will be used as a Dissertation. In addition, the Primary Investigator will seek to use the results for publication and presentation at a School Psychology conference.

Part 5.3: Existing Data - Social, Behavioral, or Educational

Use of existing data, including public use or restricted use datasets. Existing data refers to data that were NOT collected as part of this study but have been already collected before this application is submitted.

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Please select all the types of datasets you are using for this study.

- | | |
|--|---|
| <input type="checkbox"/> Public Use Data | <input checked="" type="checkbox"/> Data that may be protected by FERPA regulations |
| <input type="checkbox"/> De-identified Datasets | <input type="checkbox"/> Data that may be protected by HIPAA regulations |
| <input type="checkbox"/> Restricted Use Datasets | <input type="checkbox"/> Other, please state |

For each dataset indicated above, please provide a brief description and the databank or source from which the data will be or has been obtained.

The source of the data to be used in the study will be daily intervention assessment materials from a rural Oklahoma elementary school. The students' names will be on the assessment materials at the time of retrieval; however, the names will be removed and replaced with a random number. No one other than the Primary Investigator will have access to the students' real names. The study will use pseudonyms when reporting the results.

Can the names or identities of subjects in the datasets be deduced from the datafields?

- ☒ Yes ☐ No

Do you plan to merge geographic, company, census, community, or other data that could reasonably lead to identification of individuals in the dataset?

- ☐ Yes ☒ No

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Section 5.5: Other Regulatory Applicability - FERPA

[FERPA \(Family Education Rights and Privacy Act, 20 U.S.C. § 1232g; 34 CFR Part 99\)](#) governs the privacy and/or use of educational records. A signed disclosure is required in most cases.

For assistance with FERPA, please see the [OSU FERPA Web page](#).

Note: An approved IRB for this study does not grant permission to access the requested data records. Additional approvals will need to be obtained. At OSU, these records are requested through an AIRS data request and must be approved by the Registrar and IT Security if current or former student records are requested. Your request should state this request is for a research study.

Are you requesting a waiver of written authorization to access education records through FERPA?

☒ Yes

☐ No, Students will be giving signed consent.

FERPA requires a signed disclosure authorization unless one of the following conditions are met. Please select the appropriate condition that applies to your study:

☐ Directory Information ([34 CFR §99.31](#))

☐ De-identified records, including the removal of all direct and indirect identifiers.

☒ The study is for, or on behalf of, the institution to either develop, validate, or administer predictive tests; administer student aid programs; or improve instruction.

Note: This exemption requires a written agreement between the institution and the researcher, as per 34 CFR §99.31(a)(6)(iii). Please submit the agreement with the application. For OSU student records, please submit a copy of the approved AIRS data request.

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Please discuss how your study meets the guidelines required by the agency or act indicated above. Please be as specific as possible.

For a waiver of written authorization, please discuss the following:

- how you have a legitimate educational interest in the data and/or how conducting this study will be for or on behalf of an educational institution;
- what information/data to be disclosed by the school;
- why this information/data is needed;
- how the study will be conducted so that students or parents are not identified by anyone other than the researchers
- time period in which the researchers must de-identify, destroy, or return information to the school.
- state that information from the records may only be used to meet the purpose of this study.

The students' names will be on the assessment materials at the time of retrieval; however, the names will be removed and replaced with a random number. No one other than the Primary Investigator will have access to the key for the students' real names. The study will use pseudonyms when reporting the results.

In an effort to ensure that students are on grade level in the area of mathematics, the elementary school uses a Response to Intervention (RtI) model of tiered supports. Under this instructional model, three levels (called "tiers") of educational support and intervention are provided to students based on their instructional needs. Students performing below grade level will be provided an intervention to help them become proficient in mathematics. In order to continuously improve instruction and academic intervention techniques, the school uses structured methods to implement interventions. Through their structure of data collection, integrity and fidelity are maintained at a high standard in order to analyze the results to inform teachers on the intervention's effectiveness. The data collection also assists the school to improve intervention effectiveness, when necessary.

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Part 6: Subjects, Recruitment, & Compensation

Please check all descriptors that apply to the target population:

- | | | |
|--|---|--|
| <input type="checkbox"/> Healthy Adults | <input type="checkbox"/> Males | <input type="checkbox"/> Economic Disadvantages |
| <input checked="" type="checkbox"/> Children (Under 18) | <input type="checkbox"/> Females | <input type="checkbox"/> Educational Disadvantages |
| <input type="checkbox"/> Pregnant Women/Fetus | <input type="checkbox"/> LGBTQ | <input type="checkbox"/> Physical Disabilities |
| <input type="checkbox"/> Prisoners/Felons | <input type="checkbox"/> Native Americans | <input type="checkbox"/> Intellectual Disabilities |
| <input type="checkbox"/> Institutionalized | <input type="checkbox"/> Older Adults (65+) | <input type="checkbox"/> Specific Health Conditions and/or End of Life |
| <input type="checkbox"/> Wards of the State | | |
| <input type="checkbox"/> Employees and/or Supervisors | <input type="checkbox"/> Live in a Foreign Country | |
| <input type="checkbox"/> Students in your class | <input type="checkbox"/> Unable to read, speak, or understand English | |
| <input type="checkbox"/> Community Engaged and/or participatory research | <input type="checkbox"/> Limited Literacy | |
| <input type="checkbox"/> Internet Methodologies | <input type="checkbox"/> Undocumented | |
| | <input checked="" type="checkbox"/> Students in Elementary or Secondary Schools | |

Please provide the age range of the subjects.

The age range of the participants involved in the service project are 4-5 years old.

Please indicate the most recent date the PI and/or advisor has completed the OSU training titled, [Working with Minors](#). This training must be completed every 12 months.

Working with Minors was completed in May 2017 by Sheridan Smith.

Please describe the subject population you have chosen for this project including inclusion or exclusion criteria for subject selection.

The participants in this service project are from Pre-K and Kindergarten classrooms. To be included, the participants needed to be able to count from 1-20 orally and not be able to identify numbers 1-10. To determine the participants skill level in these areas, they are assessed using curriculum based measurements on an individual basis.

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| | |
|--|---|
| What is the minimum number of subjects needed for your study to achieve valid results? | 3 |
| How many subjects do you expect to recruit? | 3 |
| Is there a limit on the number of subjects you will include in the study? If yes, please state the number. | |

Please select all of the tools that you plan to use to [recruit](#) your subjects:

- ☐ Flyers

☐ Notices/News Releases

☐ Mailers (US Post)

☐ TV, Radio, or Print Advertisements

☐ SONA System

☐ Education

☐ Management

☐ Marketing

☐ Psychology

☒ Other, please describe below

Gained principal permission; School Academic Screening Information

☐ Online Advertisements

☐ Social Media

☐ E-mail

☐ Appendix A from IRIM

☐ Personal Contacts

☐ Face to Face Personal Intercept

☐ Presentation at Meeting

☐ Snowball Methods

☐ mTURK

☐ Paid Panel Service (SSI, etc.)

Describe, step-by-step, in layman's terms, all procedures you will use to recruit subjects. Please elaborate on any considerations needed for special populations. Submit with this application a copy of all materials to be used to invite subjects to participate.

I gained principal permission to provide the educational intervention to Pre-K and Kindergarten students behind in early numeracy. The school uses Response to Intervention (RTI) to provide support for struggling students. The early numeracy intervention I provided was a part of the school's RTI system as a Tier 2 intervention. A part of the school's RTI system is notifying parents when they are falling behind in reading or math. In addition, parents are informed of the intervention that will be provided to their student. Therefore, a parent notification letter was sent to each participant's parent/guardian to inform them of the intervention their student will be receiving and listed the details of the intervention.

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Will subjects be compensated for their participation?

☐ Yes ☒ No

Part 7: Risks, Benefits, Privacy & Confidentiality

From the list below, please select ALL of the potential risks that are involved in your study.

- ☐ Social or Economic Risks (reputation, employability, cultural, etc.)
- ☐ Breach of privacy of subject or subjects family members
- ☐ Injury or bodily harm
- ☐ Identification of illegal activity
- ☐ Identification of child, spousal, or elder abuse
- ☐ Presentation of materials which some subjects may consider sensitive, offensive, threatening, or degrading
- ☐ Probing for personal or sensitive information in surveys or interviews (e.g. private behaviors, employer assessments, etc.)
- ☐ Manipulation of psychological or social state such as sensory deprivation, social isolation, or psychological stress
- ☒ Use of private records (such as educational or medical records)
- ☐ Use of deceptive techniques. This includes incomplete disclosure.
- ☐ There are no risks of any kind to any subjects enrolled in this study.
- ☐ Other risks, please state below.

Describe the nature and degree of risk or harm selected above. All of the risks/harms must be disclosed in the consent form. If using deception, please justify its use.

There are no risks of any kind to any participants. The intervention provided by the service project was a natural part of a school's Response to Intervention system. The Primary

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Investigator providing the intervention worked as an external academic coach and interventionist for rural schools in Oklahoma through an interlocal cooperative and Oklahoma State University. The principal signed a consent form to allow the intervention to occur because the Primary Investigator was not an internal staff member and the intervention was new.

Describe the steps that will be taken to minimize risks or harms and to protect the welfare of subjects. Include a description of how you will handle an adverse or unexpected outcome that could potentially be harmful (e.g., suicidal ideation). If the study will include [protected populations](#), identify each group and provide an explanatory paragraph for each group.

There are no risks of any kind to any participants. The intervention provided by the service project was a natural part of a school's Response to Intervention system.

If using the Internet or other electronic means to collect data, what confidentiality or security precautions are in place to protect (or not collect) identifiable data? Include protections used during both the collection and the transfer of data. Please describe the survey distribution method to be used (e.g. Qualtrics Anonymous Link, Qualtrics Anonymize option, etc.)

Not applicable.

Section 7.2: Benefits

Describe any benefits that individuals may reasonably expect from participating. If there are none, please state, "none."

The benefits include gaining knowledge of early numeracy in number identification, object counting, and number writing skills.

Describe the anticipated benefit of this study to society, academic knowledge, or both.

Research suggests that competence in early numeracy skills is critical for early elementary students to succeed in more advanced mathematical tasks. Evidence is accumulating that the early elementary grades represent a pivotal time in which the investment of resources may maximize student outcomes in numeracy skills. In addition, research indicates that 4th grade students in America ranked 11th out of 36 nations and 8th grade students ranked 9th out of 48 countries in mathematics (Olson, Martin, & Mullis, 2008). Therefore, more effective methods of teaching early numeracy skills are needed that will help students succeed in mathematics. This service project's results will also add to the current academic literature base. Currently, there are no evidence-based small group early numeracy interventions available. In addition, researchers are beginning to incorporate technology in academic

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interventions. This service project's utilization of PowerPoints to teach early numeracy skills could add to the literature on the uses of technology in the classroom.

Section 7.3: [Privacy & Confidentiality](#)

Data are collected:

- ☐ Anonymously with no direct or indirect coding, link, or awareness of who participated in the study.
- ☐ Confidentially, but without a link of subject's data to any identifying information (collected as confidential but recorded and analyzed as anonymous).
- ☒ Confidentially with collection and protection of linkages to identifiable information.

Will you or any member of your research team collect or have access to any of the personal identifiers listed below? Select all that apply.

- ☒ Name
- ☐ Date of Birth
- ☐ Mailing or e-mail address
- ☐ Phone or fax numbers
- ☐ Social Security Number
- ☐ CWIDs/Banner IDs
- ☐ License, certificate, or other IDs
- ☐ IP Address
- ☐ Biometric Identifiers
- ☐ Photos/Images/Audio Recordings/Video Recordings
- ☐ Signatures or handwriting samples
- ☐ Other

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☐ No member of the research team will have access to any personal identifiers

Describe why each identifier is required.

The participants' names are needed to collect accurate data during intervention and assessment. In the case of publication, a random number or pseudonym will be used to identify each participant.

Describe how and where the information will be stored and secured, including the types of devices used to store the information.

The names will be on the intervention and assessment materials. The materials will be stored in a confidential file cabinet in a locked office. All materials with identifying names are paper products only.

Who will have access to the identifiers? Please describe how you have ensured that non-authorized personnel do not have access to the identifier data.

The primary investigators and three graduate students that assisted in gathering data. At the end of the service project, only the primary investigators will have access to the identifying information.

What will be done with the identifiers and/or any master keys linking names to subject numbers after the study is completed? How will the identifiers be removed? When is the latest date that identifying information or links will be retained?

The paper products that will have the participants' scores on them will be kept for at least 10 years and then shredded. At the time of data retrieval, participants' names will be removed and replaced with a random number. Only the Primary Investigator will have access to the key to the participants' real names.

Will names or other identifiers be used in publications?

☐ Yes
☒ No

Please provide any additional detail on how you will ensure the security of the data and confidentiality of private information.

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Part 8: [Consent Process](#)

Will you use a [written informed consent form](#)?

☐ Yes

☐ No, I am seeking a [waiver of written informed consent](#). My subjects will not be signing a consent form. Select this option for all internet and phone/skype methodologies.

☐ No, I am seeking a [waiver of informed consent](#). I am requesting to waive consent entirely or an element of informed consent such as an accurate description of the study. You need to select this option if your study involves deception.

☒ Please check this box if your study involves children and adolescents.

Will you obtain [written assent](#) for children and individuals under the age of 18?

☐ Yes

☒ No, I am seeking a [waiver of written assent](#). My subjects will not be signing an assent form.

☐ No, I am seeking a [waiver of assent](#). I am requesting to waive assent entirely.

Please provide a justification for why written assent is not appropriate for your study.

☒ The research presents no more than minimal risk of harm to participants and involves no procedures for which written consent is normally required outside of the research context.

☐ The only record linking the participant and the research would be the consent document and the principal risk would be potential harm resulting from a breach of confidentiality.

Please select the consent process that you propose to use in this study, as an alternative to written assent.

☐ [Participant Information Form](#)

☒ Oral Consent

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☐ Debriefing after the event

☐ Other, please state

Describe, step-by-step, all procedures and methods that will be used to assent subjects. Include the context, how, when, and how often (for multiple phase studies) assent will be sought and who will be responsible for seeking assent.

Verbal assent of participants was gained prior to beginning the intervention.

Will you obtain written parental or guardian permission for children and individuals under the age of 18?

☒ Yes

☐ No, I am seeking a [waiver of written parental/guardian permission](#). My subjects will not be signing a parental/guardian permission form. Select this option if using an opt-out process.

☐ No, I am seeking a [waiver parental/guardian permission](#). I am requesting to waive parental/guardian permission entirely.

Please describe the proposed parental permission process. Include the context, how, when, and how often (for multiple phase studies) parental permission will be sought and who will be responsible for seeking parental permission.

The Principal Investigator will contact the school principal to gain permission to contact the parents of the students that received the intervention. Then the Principal Investigator will send the parent permission form to the students' parents to read and sign if they give permission. Only after parent permission is obtained will the Principal Investigator will begin the study.

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Part 9: Signatures

Principal Investigator's Assurances

1. I certify that all information provided in this application is complete and correct.
2. I understand that, as Principal Investigator, I have the ultimate responsibility for the conduct of this study, the ethical performance of this project, the protection of the rights and welfare of human subjects, and strict adherence to any stipulations imposed by the OSU IRB.
3. I agree to comply with all [OSU policies and procedures](#), as well as with all applicable federal, state, and local laws regarding the protection of human subjects, including, but not limited to the following:
 - a. Conducting the project by qualified personnel according to the approved protocol.
 - b. Implementing no changes in the approved protocol without prior [modification](#) approval from the IRB.
 - c. Obtaining [informed consent](#) from each participant or their legally responsible representative prior to their participation in this project employing only the currently approved means of consent (e.g., form).
 - d. Promptly reporting [unanticipated problems and/or adverse events](#) to the IRB in writing within 5 working days after learning of the occurrence.
 - e. Conduct this study only during the time period approved by the OSU IRB.
4. I will prepare and submit a [continuation request](#) and supply all supporting documents to the IRB office at least two weeks before the approval period has expired if it is necessary for me to continue the research project beyond the time period approved by the OSU IRB.

My signature indicates that I have read, understand and agree to conduct this research project in accordance with the assurances listed above.

Signature

Sheridan Smith

Digitally signed by Sheridan Smith
Date: 2017.05.09 15:30:19 -0500

Date

May 9th, 2017

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Faculty Advisor Assurances

1. I have read the protocol submitted for this project for content, clarity, and methodology.
2. By my signature as faculty advisor on this research application, I certify that the student or guest investigator (i.e. visiting scholar) is knowledgeable about the regulations and policies governing research with human subjects and has sufficient training and experience to conduct this particular study in accord with the approved protocol.
3. I agree to meet with the investigator on a regular basis to monitor study progress. Should problems arise during the course of the study, I agree to be available, personally, to supervise the investigator in solving them.
4. I assure that the investigator will promptly report [unanticipated problems and/or adverse events](#) to the IRB.
5. If I will be unavailable, I will arrange for an alternate faculty sponsor to assume responsibility during my absence.
6. If the investigator is unable to fulfill requirements for submission of [continuations](#) or [modifications](#), I will assume that responsibility.

Signature **Brian Poncy** Digitally signed by Brian Poncy
Date: 2017.04.25 16:00:28 -0500

Date

Apr 25, 2017

Part 10: Training & Reminder Checklist

Human Subjects Training Needed:

Please complete training at the Collaborative Institutional Training Initiative ([CITI website](#)). Specific enrollment instructions can be found at the [OSU Training & Education Web Page](#). Please submit your training completion report with your application.

The training requirements listed below were identified as necessary due to responses made in this application. All PIs and research staff must complete and pass these modules.

- ☒ IRB Social, Behavioral, or Educational (SBE) Basic Course
- ☐ OSU Working with Minors Policy Training (both SBE and Biomedical)
- ☒ Research with Children - SBE (ID: 507) OR Research Involving Children - Biomedical (ID: 9)
- ☒ Research in Public Elementary or Secondary Schools (ID: 508)

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Documents Needed:

Please submit the following documents, if applicable, as an attachment to your e-mail when submitting the application. Include all attachments in either MS Word or Adobe PDF document format only. All pages for each appendix should be combined into one file labeled with the appendix letter and title. Applications and appendices are only accepted electronically via the main PIs OSU e-mail account. Select the Submit button below to e-mail the IRB. If you use a webmail client (e.g. Cowboy or Orange Mail) you will need to submit your form manually not using the submit button to irb@okstate.edu.

[Forms](#) and [templates](#) are available on the OSU IRB website.

☒ Appendix F: Consent Forms, Recruitment Scripts, Debriefing Scripts

☒ Appendix H: 4 page CVs or Résumés and CITI Training Completion Reports for all PIs

☐ Appendix J: Letters of Support and/or Permission, Photo Releases, Deeds of Gifts, Procedure Guides, Training Guides, Medical Device Information & other Supporting Materials

Save

Print

Reset

Submit

Appendix C: School Principal Consent Form

Letter of Agreement from Indian Camp Elementary

December 12, 2016

Title of Intervention: Numeracy Development Modules (NDM)
Primary Interventionist: Sheridan Smith, MS

As a representative of the Indian Camp Elementary, I confirm that we grant permission for the proposed intervention to be conducted with students as a service to the school. The intervention includes instruction on three early numeracy skills: number identification, object counting, and number writing. The intervention uses evidence-based methods to efficiently and effectively teach the three early numeracy skills. In addition, the students' learning will be monitored regularly to ensure the intervention is working to increase early numeracy skills. We are excited to have the opportunity for students at Indian Camp Elementary to receive this intervention.

This intervention will be part of the Response to Intervention (RtI) model of tiered supports we are already implementing at Indian Camp Elementary, therefore we believe there will be no risks for participating in the intervention. We also believe there are benefits of participating in the use of the intervention, including providing additional support to students at risk of falling behind in mathematics, and increasing the time teachers are able to work with other students needing support.

Printed Name of Public School Official

Title of School Official

Signature of Public School Official

Date

Appendix D: Number Identification Assessment

Number Identification Assessment

Student/Class: _____ Date: _____ Time (Start/Stop): _____

Assessor: _____

- ☐ Place the student Number Identification Assessment probe in front of the student and say, ***“When I say go, I want you to point to each number and tell me its name. Ready? Put your finger under the first number. Begin.”***
- ☐ Start the timer. Mark any errors the student makes on the administrator form.
 - If the student pauses for 5 seconds on a number, say ***“Try the next number.”***
- ☐ After the last number, stop the timer.
 - Record the duration it took the student to complete the assessment.
- ☐ Record the Correct Numbers Identified.
 - Total Numbers – Errors = **Numbers Correctly Identified**

| | | | | |
|---|----|---|---|---|
| 8 | 2 | 1 | 9 | 4 |
| 6 | 10 | 5 | 3 | 7 |

Numbers Correctly Identified _____

Number Identification Probe – Student Form

| | | | | |
|---|----|---|---|---|
| 8 | 2 | 1 | 9 | 4 |
| 6 | 10 | 5 | 3 | 7 |

Appendix E: Circle Number Assessment

Circle Number Assessment

Name: _____ **Date:** _____ **Time (Start/Stop):** _____

Assessor: _____

Timing: Student pauses for 5 seconds on item, prompt to skip and go to next item

Materials needed: Probe sheets for each student, pencils for each student, digital timer

- ☐ Tell the student,
 - *“You will be doing a fun activity today.”*
- ☐ Distribute probe sheets. Prompt student,
 - *“Write your name at the top of the paper and then put your pencil down when you have finished so that I know you are ready.”*
- ☐ Introduce student to the task on the PowerPoint slide,
 - *“Look at the circles on the left (point). Your job is to count the circles here and circle the number that matches it on the right (pointing). Let’s do the first one together on the board. Let’s count these circles aloud. (Count with the student). How many circles are there? Three, that’s right! Now, which number do you circle over here? Three, that’s right.”*
- ☐ Prompt student to begin,
 - *“Now you know how to do the activity. Start at the top of the page and keep working till you finish every problem. Ready, set, go.”*
- ☐ Begin the timer. Prompt student to **“Try the next one”** if they pause for 5 seconds.
- ☐ Do not assist or teach the student the task during the assessment.

- Say only, “***Do your best work***” if the student asks questions during the assessment.
- When the student completes the last item, stop the timer and record the time of completion and collect the assessment probes.
- Record the Correct Numbers Circled.
 - Total Numbers – Errors = Correct Numbers Circled: _____




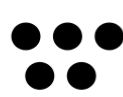
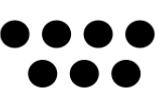


Scoring:

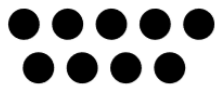
1. Count number correct and amount of time for completion.
2. Count number of errors. Errors are defined as more than one number circled or the wrong number circled.
3. If the student does not attempt an item, it is not counted as an error.

Circle Number Assessment Probe

Circle Number Probe, Form A

VanDerHeyden et al., 2001

| | | | | | |
|---|---|---|----|---|----|
|  | <table><tr><td>1</td><td>4</td><td>3</td><td>2</td></tr></table> | 1 | 4 | 3 | 2 |
| 1 | 4 | 3 | 2 | | |
|  | <table><tr><td>1</td><td>5</td><td>3</td><td>2</td></tr></table> | 1 | 5 | 3 | 2 |
| 1 | 5 | 3 | 2 | | |
|  | <table><tr><td>2</td><td>3</td><td>4</td><td>5</td></tr></table> | 2 | 3 | 4 | 5 |
| 2 | 3 | 4 | 5 | | |
|  | <table><tr><td>4</td><td>5</td><td>3</td><td>2</td></tr></table> | 4 | 5 | 3 | 2 |
| 4 | 5 | 3 | 2 | | |
|  | <table><tr><td>6</td><td>5</td><td>7</td><td>10</td></tr></table> | 6 | 5 | 7 | 10 |
| 6 | 5 | 7 | 10 | | |
|  | <table><tr><td>1</td><td>5</td><td>3</td><td>2</td></tr></table> | 1 | 5 | 3 | 2 |
| 1 | 5 | 3 | 2 | | |
|  | <table><tr><td>1</td><td>5</td><td>8</td><td>2</td></tr></table> | 1 | 5 | 8 | 2 |
| 1 | 5 | 8 | 2 | | |



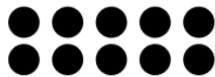
| | | | |
|---|---|---|---|
| 7 | 5 | 8 | 9 |
|---|---|---|---|



| | | | |
|---|---|---|---|
| 1 | 3 | 8 | 2 |
|---|---|---|---|



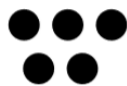
| | | | |
|---|---|---|---|
| 3 | 4 | 5 | 6 |
|---|---|---|---|



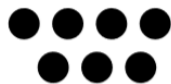
| | | | |
|---|---|---|----|
| 1 | 9 | 5 | 10 |
|---|---|---|----|



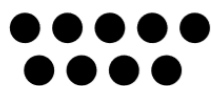
| | | | |
|---|---|---|---|
| 1 | 4 | 3 | 2 |
|---|---|---|---|



| | | | |
|---|---|---|---|
| 5 | 6 | 3 | 4 |
|---|---|---|---|



| | | | |
|---|---|---|---|
| 6 | 4 | 8 | 7 |
|---|---|---|---|



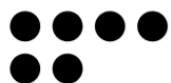
| | | | |
|---|---|---|---|
| 8 | 5 | 9 | 7 |
|---|---|---|---|



| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 5 |
|---|---|---|---|



| | | | |
|---|---|---|---|
| 6 | 8 | 7 | 9 |
|---|---|---|---|



| | | | |
|---|---|---|---|
| 1 | 5 | 6 | 3 |
|---|---|---|---|



| | | | |
|---|---|---|---|
| 3 | 4 | 5 | 2 |
|---|---|---|---|



| | | | |
|---|---|---|----|
| 7 | 9 | 8 | 10 |
|---|---|---|----|

Appendix F: Number Writing Assessment

Number Writing Assessment

Student/Class: _____ Date: _____ Time (Start/Stop): _____

Assessor: _____

- ☐ Pass out the Number Writing probe to the student and instruct them to write their name at the top of the paper.

- ☐ Say to the student,

“Today we are going to do number writing. Look at your worksheets. On the worksheet you will see rows of blank boxes. I am going to say a number and you will write that number in the first box. Then, I will continue saying numbers for you to write, going across the page. If you do not know how to write a number, draw an X through the box and wait for the next number. Make sure to follow along, do not skip ahead or fall behind. Do you have any questions? Okay, ready, let’s begin”.

- ☐ After all numbers are said, give the student praise for working and collect the worksheet.

- ☐ Record the Correct Numbers Written.

a. Total Numbers – Errors = Correct Numbers Written: _____

Scoring:

1. Numbers written properly in the appropriate box are scored as correct.
2. Numbers written backward or incomplete are scored as incorrect.

| | | | | |
|---|---|---|---|----|
| 8 | 5 | 3 | 6 | 10 |
| 2 | 7 | 9 | 1 | 4 |

Number Writing Probe - Student Form

| | | | | |
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Appendix G: Intervention Integrity Checklists

Number Identification Integrity Checklist

Student: _____ Date: _____ Time (Start/Stop): _____

Interventionist: _____ Independent Observer: _____

Materials: ☐ NDM Worksheets ☐ Implementation Checklist ☐ Pencil ☐ PowerPoint file

Procedures:

- ☐ Set up the Beat the Clock: Number Identification PowerPoint.
- ☐ Read the following directions to the students:
"Today we are going to do something new. We are going to play a game called beat the clock to learn our numbers. I am going to start the computer and a number is going to show up on the screen one at a time. When a number appears, you will hear a beep. As soon as you hear the beep, say the correct number name as fast as you can! It is your job to try and beat the clock by saying the number before the computer says it. If you say a different number, say the correct number quietly to yourself. Are there any questions? Ok, let's practice." (Start the PowerPoint.)
- ☐ When you see the Stop sign on the PowerPoint, press pause (the S key). Say to the students,
"Now the numbers will appear out of order. See how fast you can name them!"
- ☐ Walk around the room to ensure that students are following along with the PowerPoint, trying to beat the clock. Give students praise for paying attention and saying the correct numbers.
- ☐ When you see the Stop sign and "Break!" on the PowerPoint, allow students to stand and participate in the break activity. Then ask them to sit down and say,
"Now you will see the numbers again, but there will be more than one on the screen. One at a time, the numbers will be underlined and you will hear the beep. When you hear the beep, say its name as fast as you can. Don't skip ahead! Say the names one at a time after you hear the beep. Are there any questions? I am going to start the computer. Ready, begin". (Start PowerPoint).
- ☐ Walk around the room to ensure that students are following along with the PowerPoint, trying to beat the clock (not just saying the numbers at once), and to provide behavior specific praise to students who are following the correct procedures.

Object Counting Integrity Checklist

Student: _____ Date: _____ Time (Start/Stop): _____

Interventionist: _____ Independent Observer: _____

Materials: ☐ NDM Worksheets ☐ Implementation Checklist ☐ Pencil ☐ PowerPoint file

Procedures:

- ☐ Set up the Object Counting PowerPoint.
- ☐ Start the PowerPoint.
- ☐ Walk around the room to ensure that students are following along with the PowerPoint. Give students praise for paying attention and counting along.
- ☐ When the "Break!" appears on the PowerPoint, allow students to stand and participate in the break activity. Then ask them to sit down and pass out the Object Counting Practice Probe.
- ☐ Say to the students,
"Look at the circles on the left (point). Your job is to count the stars and circle the number that matches it on the right (pointing). Let's do the first one together. Let's count these stars aloud. (Count with the students). How many stars are there? Four, that's right! Now, which number do you circle over here? Four, that's right! Now you know how to do the activity. Work as quickly as you can. Keep working until you finish the last problem. Ready, set, go!"
- ☐ Walk around the room to ensure that students are working on the Object Counting Practice Probe and to provide behavior specific praise to students who are following the correct procedures.
- ☐ At the end of the PowerPoint, walk around and provide corrective feedback for students to fix mistakes.

Number Writing Integrity Checklist

Student: _____ Date: _____ Time (Start/Stop): _____

Interventionist: _____ Independent Observer: _____


Materials: ☐ NDM Worksheets ☐ Implementation Checklist ☐ Pencil ☐ PowerPoint file

Procedures:


- ☐ Set up the Number Writing PowerPoint on the computer.
- ☐ Read the following directions to the students,
"Today we are going to do something new. We are going to practice writing numbers using something called Taped Problems. (Pause) Look at your worksheets. On the worksheet you will see rows of numbers. I am going to start the computer and it is going to read each number going across the page. Specifically, the computer will pause before each number, and then say a number. It is your job to try to write the number as best as you can before the computer says the next number. If you make a mistake, cross out what you wrote and write down the correct number below it. Make sure to follow along with the computer, do not skip ahead or fall behind it. Are there any questions? Okay, let's practice. I am going to start the computer and we are going to do the first row and then stop. Ready, begin."
- ☐ Start the PowerPoint. After the first row, press pause and say,
"If anyone is unsure of how to do taped problems, then raise your hand and I will come to your desk and help you. I am going to restart the computer and we will finish the page. Ready, begin."
- ☐ Play the PowerPoint.
- ☐ Walk around the room to ensure that students are following along with the PowerPoint. Give students praise for working.
- ☐ When the "Break!" appears on the PowerPoint, allow students to stand and participate in the break activity. Then ask them to sit down, turn their page over and get ready to keep working.
- ☐ Walk around the room to ensure that students are working on the Number Writing Probe and to provide behavior specific praise to students who are following the correct procedures.
- ☐ At the end of the PowerPoint, walk around and provide corrective feedback for students to fix mistakes.

Appendix H: Sample Intervention Probes


Object Counting Probe




| | | | |
|---|---|---|---|
| 8 | 4 | 7 | 5 |
|---|---|---|---|




| | | | |
|---|---|---|---|
| 3 | 2 | 4 | 1 |
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|---|---|---|---|
| 3 | 6 | 2 | 4 |
|---|---|---|---|




| | | | |
|----|---|---|---|
| 10 | 5 | 3 | 4 |
|----|---|---|---|



| | | | |
|---|---|---|---|
| 8 | 4 | 9 | 3 |
|---|---|---|---|



| | | | |
|---|---|---|---|
| 1 | 6 | 2 | 5 |
|---|---|---|---|



| | | | |
|---|---|---|---|
| 5 | 4 | 8 | 7 |
|---|---|---|---|

Number Writing Guided Practice Probe

Name: _____

Date: _____

Number Writing Guided Practice 6-10 Probe 1a

| | | | | |
|---|---|---|---|----|
| 6 | 7 | 8 | 9 | 10 |
| 6 | 7 | 8 | 9 | 10 |

| | | | | |
|---|---|---|---|----|
| 6 | 7 | 8 | 9 | 10 |
| 6 | 7 | 8 | 9 | 10 |

| | | | | |
|---|---|----|---|---|
| 6 | 8 | 10 | 7 | 9 |
| 6 | 8 | 10 | 7 | 9 |

| | | | | |
|---|---|---|----|---|
| 7 | 6 | 8 | 10 | 9 |
| 7 | 6 | 8 | 10 | 9 |

Number Writing Combined Independent Practice Probe

Independent Practice 1-10 Probe 1a

| | | | | |
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VITA

SHERIDAN CHRISTINE SMITH

Candidate for the Degree of

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Dissertation: USING TECHNOLOGY WITH KINDERGARTEN STUDENTS
TO INCREASE EARLY NUMERACY SKILLS

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